UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Master Biophysics 2019

Version from 1. October 2019

biophysics

advanced curriculum

module part

Elective

BP4110-KP08 - theoretical biophysics (ThBP)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every winter semester	8

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 1st and 2nd semester

Classes and lectures:

- theoretical biophysics (exercise, 1 SWS)
- theoretical biophysics (lecture, 2 SWS)
- molecular dynamics (lecture, 2 SWS)
- molecular dynamics (exercise, 1 SWS)

Workload:

- 150 Hours private studies
- 90 Hours in-classroom work

Contents of teaching:

- Basic concepts of quantum mechanics
- Intra- and intermolecular interactions
- Description of molecules by classical models
- Simulation of the dynamics of molecules by means of Newtonian mechanics
- Description of molecular dynamics with the help of thermodynamics
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Qualification-goals/Competencies:

- Students can explain how the existence of atoms and molecules can be explained from the fundamental assumptions of quantum mechanics.
- They can explain, within what limits can be described by classical models the interactions between atoms.
- They can sketch an algorithm with which the dynamics of molecules can be simulated.
- They can list, which thermodynamic concepts are to describe the molecular dynamics.
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Grading through:

- Oral examination

Requires:

- Module part: Biophysik 1 (ME4600 C)

Responsible for this module:

- PD Dr. rer. nat. Hauke Paulsen

Teacher:

- Institute of Physics

- PD Dr. rer. nat. Hauke Paulsen
- Prof. Dr. rer. nat. Christian Hübner

Literature:

- V. Schünemann: Biophysik - Berlin: Springer 2004
- M. Daune: Molekulare Biophysik - Braunschweig: Vieweg 1997
- Andrew R Leach: Molecular Modelling: Principles and Applications - Prentice Hall, 2nd edition 2001

Language:

- German and English skills required

BP4510-KP12 - experimental biophysics (ExpBP)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	12

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 2nd semester

Classes and lectures:

- Proteinbiophysics (exercise, 1 SWS)
- Proteinbiophysics (lecture, 2 SWS)
- Basics of Membrane Biophysics (lecture, 2 SWS)
- Basics of Membrane Biophysics (exercise, 1 SWS)
- Instrumentation in Biophysics (exercise, 1 SWS)
- Instrumentation in Biophysics (lecture, 2 SWS)

Workload:

- 225 Hours private studies
- 135 Hours in-classroom work

Contents of teaching:

- Protein structure
- Energy landscapes
- Thermodynamics of protein folding
- Thermodynamics of protein folding
- Kinetics of protein folding
- Thermodynamics of enzymatic reactions
- Kinetics of enzymatic reactions
- Importance and function of cell membranes: structure, physical function and dynamic models
- Basics of the membrane components
- Thermodynamic self-assembling of lipids and reconstitution techniques
- Transmembrane and intrinsic membrane potentials
- Mechanical properties of lipid membranes
- Physical basics of membrane transport mechanisms
- Investigations using lipid monolayer
- Electrical and optical experiments using planar lipid bilayers
- Examples for interaction mechanisms between peptides/ proteins and planar membranes
- Spectroscopic methods on membranes and membrane proteins
- Light and force microscopy on membranes and membrane proteins
- UV-VIS spectroscopy
- Atomic force microscopy
- Fluorescence spectroscopy
- Film balance
- Patch clamp

Qualification-goals/Competencies:

- Understanding of physical principles of:protein folding, protein Dynamics, protein interactions
- Constituents and composition of biological membranes
- Physical role and function of membrane lipids and proteins
- Mechanical and electrical properties of membranes
- Various methods to investigate reconstituted and natural membranes
- Students will be able to identify the appropriate instrumentation for a particular biophysics question
- The students are able to further develop the instruments of biophysics.
- The students are able to optimally use the instruments of biophysics.

Grading through:

- Oral examination

Requires:

- Introduction into Biophysics (LS2200-KP04, LS2200)

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Research Center Borstel
- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner
- PD Dr. rer. nat. Hauke Paulsen
- Prof. Dr. rer. nat. Thomas Gutsmann
- PD Dr. rer. nat. Andra Schromm
- Dr. Christian Nehls

Literature:

- Hans Frauenfelder, Shirley Chan und Winnie Chan: Physics of Proteins: An Introduction to Molecular Biophysics (Biological and Medical Physics, Biomedical Engineering) - von Springer, Berlin (Gebundene Ausgabe - 30. Dezember 2010)
- Alan Fersht: Structure & Mechanism in Protein Science: Guide to Enzyme Catalysis and Protein Folding - W H Freeman & Co (Gebundene Ausgabe - 15. Februar 1999)
- Meyer B. Jackson: Molecular and Cellular Biophysics - ISBN: 978-0-521-62470-1
- G. Adam, P. Läuger, G. Stark: Physikalische Chemie und Biophysik - Springer-Verlag, 4. Auflage 2003
- W. Hanke, R. Hanke: Methoden der Membranphysiologie - Spektrum Akademischer Verlag, Auflage 1997
- Ole G. Mouritsen: Life - As a Matter of Fat - Springer 2005, ISBN 987-3-540-23248-3
- Thomas Heimburg: Thermal Biophysics of Membranes - Whiley-VCH 2007, ISBN 978-3-527-40471-1
- Lukas K. Buehler: Cell Membranes - Garland Science 2016, ISBN 978-0-8153-4196-3
- Yves Dufrene (Ed.): Life at the Nanoscale - Pan Stanford Publishing 2011, ISBN 978-981-4267-96-0

Language:

- German and English skills required

BP5100-KP12 - Internship Biophysics 1 (ProPrakBP1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	12 (Typ B)

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 3rd semester

Classes and lectures:

- Internship I (September-November) (block practical course, 12 SWS)

Workload:

- 320 Hours work on project
- 40 Hours written report

Contents of teaching:

- Project management in a concrete research context
- Documentation, presentation, motivation in heterogeneous environments
- Strategies of literature research
- Analysis and curation of complex experimental data

Qualification-goals/Competencies:

- Students have a deep understanding of selected aspects of biophysics.
- They are able to realize selected aspects of biophysics.
- You are able to document and present project results.
- You are able to respond to special audiences or time restrictions (e.g. elevator pitch etc.) in a presentation.
- You have project experience in concrete application scenarios.
- You have basic competences in the field of project management.

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Studiengangsleitung

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck
- Scientific facilities at the Universität zu Lübeck or abroad with mandatory supervision by an university lecturer

- Alle Dozentinnen/Dozenten der UzL

Literature:

- is selected individually:

Language:

- German, except in case of only English-speaking participants

Notes:

The internships can be completed in auditorytechnology companies or scientific facilities outside the university as well. It is recommended to seek a place abroad.
One of the two internships can be completed in a medical institution or a clinic.
Both internships can be merged into one large internship.

BP5200-KP12 - Internship Biophysics 2 (ProPrakBP2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	12 (Typ B)

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 3rd semester

Classes and lectures:

- Internship I (September-November) (block practical course, 12 SWS)

Workload:

- 320 Hours work on project
- 40 Hours written report

Contents of teaching:

- Project management in a concrete research context
- Documentation, presentation, motivation in heterogeneous environments
- Strategies of literature research
- Analysis and curation of complex experimental data

Qualification-goals/Competencies:

- Students have a deep understanding of selected aspects of biophysics.
- They are able to realize selected aspects of biophysics.
- You are able to document and present project results.
- You are able to respond to special audiences or time restrictions (e.g. elevator pitch etc.) in a presentation.
- You have project experience in concrete application scenarios.
- You have basic competences in the field of project management.

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Studiengangsleitung

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck
- Scientific facilities at the Universität zu Lübeck or abroad with mandatory supervision by an university lecturer

- Alle Dozentinnen/Dozenten der UzL

Literature:

- is selected individually:

Language:

- German, except in case of only English-speaking participants

Notes:

The internships can be completed in auditorytechnology companies or scientific facilities outside the university as well. It is recommended to seek a place abroad.
One of the two internships can be completed in a medical institution or a clinic.
Both internships can be merged into one large internship.

BP5990-KP30 - Master Thesis Auditory Technology (BPMArbeit)		
Duration: 1 Semester	**Turnus of offer:** each semester	**Credit points:** 30

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 4th semester

Classes and lectures:

- Authoring of the Master Thesis (supervised self studies, 1 SWS)
- Colloquium (presentation (incl. preparation), 1 SWS)

Workload:

- 870 Hours private studies
- 30 Hours oral presentation (including preparation)

Contents of teaching:

- Independent scientific work on a complex task in biophysics and its application
- Scientific presentation of the problem at hand and the solutions developed

Qualification-goals/Competencies:

- The students are able to solve a complex scientific problem with state of the art methods.
- They have the expertise to plan, organize and carry out a project work.
- They can present complex information in written and oral form.
- They have gained expert knowledge on a roughly defined topic.

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung

Teacher:

- All institutes of the University of Lübeck
- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Literature:

- is selected individually:

Language:

- thesis can be written in German or English

LS4020 A - Module part LS4020A: Crystallography (StrAnaKris)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	3	60

Course of study, specific field and term:

- Master MLS 2018 (module part), structure biology, 1st semester
- Master Infection Biology 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master CLS 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS 2016 (module part), structure biology, 1st semester
- Master Infection Biology 2012 (module part), Interdisciplinary modules, 1st semester
- Master CLS 2010 (module part), computational life science / life sciences, 3rd semester
- Master MLS 2009 (module part), structure biology, 1st semester

Classes and lectures:

- Crystallography (lecture, 2 SWS)

Workload:

- 60 Hours private studies
- 30 Hours in-classroom work

Contents of teaching:

- Crystal growth, precipitant and phase diagram, crystal morphology, symmetry and space groups, crystallogenesis
- X-rays, X-ray sources, X-ray diffraction, Bragg's law, reciprocal lattice and Ewald-sphere construction
- X-ray diffraction by electrons, Fourier analysis and synthesis
- Protein structure determination by X-ray diffraction, crystallographic phase problem, Patterson map, molecular replacement (MR), multiple isomorphous replacement (MIR), multi-wavelength anomalous diffraction (MAD)
- Crystallography and the drug discovery process: studying protein-ligand interactions
- Practical exercises employing an X-ray generator (collection of a diffraction image) and the computer (MR; calculation and interpretation of electron density maps)
- Site visit at the Synchrotron DESY (Hamburg)

Qualification-goals/Competencies:

- They have a general scientific competence in macromolecular X-ray diffraction analysis
- They have the methodological competence to grow protein crystals by hanging or sitting drops
- They have the methodological competence to correctly interpret (salt or protein) the diffraction image of a crystal using the Ewald Sphere construction
- They have the methodological competence to tackle the phase problem either by MR, MIR or MAD
- They can calculate and interprete electron density maps
- They have the methodological competence, to apply structure- or fragment-based techniques for lead compound identification
- They have the communication competency to convey the principles of X-ray diffraction theory

Grading through:

- see Notes

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Biochemistry

- Dr. math. et dis. nat. Jeroen Mesters
- Prof. Dr. rer. nat. Rolf Hilgenfeld

Literature:

- Jan Drenth: Principles of Protein X-ray Crystallography - Science+Business Media, LLC, New York

Language:

- offered only in English

Notes:

Is part of Module:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

4 exercises, 2 hours each, are offered in addition to the lecture. Dates are given at the start of the semester.

For Master MLS with specialization Structure Biology the module is mandatory.

LS4020 B - Module part LS4020B: NMR Spectroscopy (StrAnaNMR)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MLS 2018 (module part), structure biology, 1st semester
- Master Infection Biology 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master CLS 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS 2016 (module part), structure biology, 1st semester
- Master Infection Biology 2012 (module part), Interdisciplinary modules, 1st semester
- Master CLS 2010 (module part), computational life science / life sciences, 3rd semester
- Master MLS 2009 (module part), structure biology, 1st semester

Classes and lectures:

- NMR-Spectroscopy (lecture, 2 SWS)

Workload:

- 60 Hours private studies
- 30 Hours in-classroom work

Contents of teaching:

- Lecture topics:
- Assignment of NMR spectra
- Description of the NOESY experiment using the vector model
- Chemical Exchange and Transfer-NOEs
- Multidimensional NMR spectroscopy
- Assignment strategy for peptides
- Introduction into the product operator formalism (POF)
- Description of the COSY and of the HSQC experiment using POF
- NMR experiments for the assignment of proteins
- NMR structural analysis of proteins
- Experiments to probe the motions of protein

Qualification-goals/Competencies:

- Advanced techniques to assign and analyze NMR spectra
- Understanding of NMR experiments based on the product operator formalism
- Basic knowledge about NMR experiments to analyze structure and dynamics of proteins

Grading through:

- see Notes

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- PD Dr. rer. nat. Karsten Seeger

Literature:

- James Keeler: Understanding NMR Spectroscopy - Wiley
- :
- Malcolm H. Levitt: Spin Dynamics - Basics of Nuclear Magnetic Resonance - Wiley-VCH
- D. Neuhaus & M. P. Williamson: The Nuclear Overhauser Effect in Structural and Conformational Analysis - Wiley-VCH
- Timothy Claridge: High-Resolution NMR Techniques in Organic Chemistry - Pergamon Press
- : Current scientific literature

Language:

- offered only in English

Notes:

This lecture is a part of modules:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

Exercises are integrated into the lectures.
It is a compulsory module part for the Master MLS with a focus on structural biology.

LS4020 C - Module part LS4020C: Single Molecule Methods (Einzelstru)

Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MLS 2018 (module part), structure biology, 1st semester
- Master Infection Biology 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master CLS 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS 2016 (module part), structure biology, 1st semester
- Master Infection Biology 2012 (module part), Interdisciplinary modules, 1st semester
- Master CLS 2010 (module part), computational life science / life sciences, 3rd semester
- Master MLS 2009 (module part), structure biology, 1st semester

Classes and lectures:

- Single Molecule Methods (lecture, 2 SWS)

Workload:

- 60 Hours private studies
- 30 Hours in-classroom work

Contents of teaching:

- Physical basics of fluorescence
- Photo physics
- Microscopy techniques
- Protein labeling
- Fluorescence resonance energy transfer
- Single molecule enzymology
- Single molecule protein folding
- Physical basics of optical tweezers
- Protein folding with optical tweezers

Qualification-goals/Competencies:

- Understanding of the physical basics of single molecule methods
- Understanding of the benefits of single molecule methods
- Understanding of the limits of single molecule methods

Grading through:

- see Notes

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner

Literature:

- Lakowicz, Joseph R: Principles of Fluorescence Spectroscopy - ISBN 978-0-387-46312-4
- Markus Sauer, Johan Hofkens, Jörg Enderlein: Handbook of Fluorescence Spectroscopy and Imaging: From Ensemble to Single Molecules - ISBN: 978-3-527-31669-4

Language:

- offered only in English

Notes:

Is module part of:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

This module part is identical to LS4020 C-MIW without seminar.
For Master MLS with specialization in structure biology the module is mandatory.

LS4020 D - Module part LS4020D: Microscopy: techniques and applications (StrAnaMikr)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MLS 2018 (module part), structure biology, 1st semester
- Master Infection Biology 2018 (module part), Interdisciplinary modules, 1st semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master CLS 2016 (module part), MML with specialization in Life Science, 3rd semester
- Master MLS 2016 (module part), structure biology, 1st semester
- Master Infection Biology 2012 (module part), Interdisciplinary modules, 1st semester
- Master CLS 2010 (module part), computational life science / life sciences, 3rd semester
- Master MLS 2009 (module part), structure biology, 1st semester

Classes and lectures:

- Microscopy: techniques and applications (lecture, 2 SWS)

Workload:

- 60 Hours private studies
- 30 Hours in-classroom work

Contents of teaching:

- Light microscopy
- Confocal microscopy
- 2-photon microscopy
- Light sources and detectors
- Fluorescent Dyes; GFP and genetically encoded fluorescence markers; Live Cell/tissue imaging: considerations/limitations
- Labelling/identifying cell components using fluorescence techniques
- Protein-protein Interactions in living cells: FRET, FLIM; Biosensors
- Photo-activatable/-switchable Fluorescent Proteins; Fluorescent Timers
- Advanced 3D-Fluoresence Microscopy, STED, PALM, STORM
- In vivo imaging in tissues and living animals
- Applications of Flow Cytometry & Fluorescence-activated Cell Sorting
- Electron Microscopy: TEM, Immunogold label; Survey of cell ultrastructure; Correlative EM/light microscopy; Scanning Electron Microscopy (SEM)
- Bioluminescence; high-content screening; outlook: emerging technologies
- Data storage/formats; Course discussion; and then: Cinema of the Cell

Qualification-goals/Competencies:

- Basics of light and fluorescence microscopy and electron microscopy
- Detailed knowledge of methods for labelling and visualization of proteins and subcellular compartments
- Applications of live cell imaging, in vivo imaging and quantitative fluorescence techniques

Grading through:

- see Notes

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Biology

- Prof. Dr. rer nat. Rainer Duden

Literature:

- -: http://micro.magnet.fsu.edu/primer/index.html
- -: http://www.microscopyu.com/smallworld/
- -: http://www.olympusmicro.com/

Language:

- offered only in English

Notes:

Is module part of:
- LS4021-KP06 (former LS4020-IB) -> Prof. Hübner
- LS4020-KP06 (former LS4020-MLS) and LS4020-KP12 -> Prof. Peters

For Master MLS with specialization in Structure Biology the module is mandatory.

(Contribution to lecture, Biology 60%)
(Contribution to lecture, Biomedical Optics 40%)

LS4020-KP12 - Structure Analysis (StrAnaKP12)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	12

Course of study, specific field and term:

- Master Biophysics 2019 (compulsory), biophysics, 1st semester
- Master MLS 2016 (compulsory), structure biology, 1st semester

Classes and lectures:

- Part of the module A: Crystallography (lecture, 2 SWS)
- Part of the module B: NMR-Spectroscopy (lecture, 2 SWS)
- Part of the module C: Single Molecule Methods (lecture, 2 SWS)
- Part of the module D: Microscopy: techniques and applications (lecture, 2 SWS)

Workload:

- 240 Hours private studies
- 120 Hours in-classroom work

Contents of teaching:

- See module parts A to D

Qualification-goals/Competencies:

- See module parts A to D

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Physics
- Institute for Biology
- Institute of Biochemistry
- Institute of Chemistry and Metabolomics

- Prof. Dr. rer. nat. Thomas Peters
- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Dr. math. et dis. nat. Jeroen Mesters
- PD Dr. rer. nat. Karsten Seeger
- Prof. Dr. rer. nat. Christian Hübner
- Prof. Dr. rer nat. Rainer Duden

Language:

- English, except in case of only German-speaking participants

Notes:

This modul has 4 parts: LS4020A-D.
BSc in Molecular Life Science or related fields.
One written examination with all parts, each valued 25%.
All four parts have to be chosen for the specialisation in Structure Biology.

ME4420-KP12, ME4420 - Biomedical Optics (BMO)

Duration:	Turnus of offer:	Credit points:
2 Semester	each winter semester	12

Course of study, specific field and term:

- Master MES 2020 (compulsory), medical engineering science, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), technology field medical engineering science, arbitrary semester
- Master Biophysics 2019 (compulsory), biophysics, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), technology field medical engineering science, 1st and 2nd semester
- Master MES 2014 (compulsory), medical engineering science, 1st and 2nd semester

Classes and lectures:

- ME4421 T: Module part: Biomedical Optics 1 (lecture, 2 SWS)
- ME4422 T: Module part: Biomedical Optics 2 (lecture, 2 SWS)
- ME4423 T: Module part: Laser physics and -technologies (lecture, 2 SWS)
- Seminar Biomedical Optics (seminar, 2 SWS)

Workload:

- 135 Hours private studies
- 120 Hours in-classroom work
- 55 Hours exam preparation
- 30 Hours oral presentation (including preparation)
- 20 Hours written report

Contents of teaching:

- as described for the module parts

Qualification-goals/Competencies:

- as described for the module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Alfred Vogel

Teacher:

- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Alfred Vogel
- PD Dr. rer. nat. Gereon Hüttmann
- Prof. Dr. rer. nat. Robert Huber
- Dr. rer. nat. Ralf Brinkmann
- Prof. Dr. rer. nat. Sebastian Karpf

Literature:

- as listed for the module parts:

Language:

- German and English skills required

ME4421 T - Module part: Biomedical Optics 1 (BioMedOp1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MES 2020 (module part), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), medical engineering science, 1st semester

Classes and lectures:

- Lecture Biomedical Optics 1 (lecture, 2 SWS)

Workload:

- 40 Hours private studies and exercises
- 30 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Tissue optics
- Photophysics of molecules, fluorescent markers, and targeting
- Photochemistry, photobiology, and photodynamic therapy
- Spectroscopic tissue characterization and diagnosis
- Raman spectroscopy and imaging
- Coherence of light, and implications for biomedical optics
- Generation, steering, and detection of light
- Thermal action of light on biomolecules and tissue, rate processes
- Selective treatment of ocular structures, guided by online-dosimetry
- Mechanisms of pulsed laser ablation
- Laser ablation at tissue surfaces and inside the body & surgery by high-intensity focused ultrasound
- Nonlinear interactions of light and matter
- Plasma-mediated surgery, exemplified on refractive corneal surgery and cataract surgery
- Optical manipulation of microstructures (Laser scissors, tweezers, and catapults)
- Plasmonic systems, nano-optics, and optical bio-sensors

Qualification-goals/Competencies:

- The students are able to describe, illustrate and compare the fundamental diagnostic and therapeutic optical techniques in biomedicine.
- They are able to assess advantages and disadvantages of these techniques and to draw conclusions for their implementation into possible applications.
- They can explain light and tissue interactions and relate them to the optical techniques in which they are used.
- The students are able to understand and classify complex optical techniques as a whole and to analyze their constitutents.
- They have a profound understanding of scientific optical techniques in biomedicine, can apply it independently, and are able to transfer their knowledge to related tasks.

Grading through:

- Oral examination

Is requisite for:

- Module part: Biomedical Optics 2 (ME4422 T)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Alfred Vogel
- PD Dr. rer. nat. Gereon Hüttmann

Literature:

- P.N. Prasad: Introduction to Biophotonics - Wiley 2003
- J. Popp, V. Tuchin, A. Chiou, S.H. Heinemann: Handbook of Biophotonics Vol 1 & 2 - Wiley-VCH 2011
- A.J. Welch, M. van Gemert: Optical-Thermal Response of Laser-Irradiated Tissue - Plenum 1995 (zweite Auflage 2011)

Language:

- offered only in German

ME4422 T - Module part: Biomedical Optics 2 (BioMedOp2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	3

Course of study, specific field and term:

- Master MES 2020 (module part), medical engineering science, 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), biophysics, 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), medical engineering science, 2nd semester

Classes and lectures:

- Biomedical Optics 2 (lecture, 2 SWS)

Workload:

- 40 Hours private studies
- 30 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Light microscopy: geometrical optics, wave optics, Fourier optics
- Effects of incoherent and coherent microscope-illumination & technical realization
- Phase contrast and differential interference contrast (DIC)
- Marker and targeting techniques, GFP, quantum dots, FRET
- Deconvolution & optical sectioning via structured illumination, confocal microscopy, 2-photon imaging
- Nanoscopy beyond the Abbe-limit: principles and biological applications
- Optical coherence tomography (OCT): principles, technical realization, and clinical applications
- Opto-acoustic tomography and microscopy
- Electron microscopy: principles and biological applications of TEM, REM, and Cryo-EM

Qualification-goals/Competencies:

- The students have a profound understanding and knowledge of modern optical imaging techniques in biomedicine, are able to describe and illustrate them, and to relate them to applications.
- They can explain the light-tissue interaction relevant for the different techniques, describe them mathematically and predict their effects.
- The students are able to understand and classify complex optical imaging techniques as a whole and to analyze their constitutents.
- They are able to transfer and adopt their knowledge to related problems and to develop new concepts.

Grading through:

- participation in discussions

Requires:

- Module part: Biomedical Optics 1 (ME4421 T)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Alfred Vogel
- PD Dr. rer. nat. Gereon Hüttmann

Literature:

- D. B. Murphy: Fundamentals of Light Microscopy and Electronic Imaging - Wiley-Liss 2001
- J. Mertz: Optical Microscopy - Roberts & Co. Publ. 2010
- J.B. Pawley (ed): Handbook of Confocal Microscopy - Springer 2006
- W. Drexler, J.G. Fujimoto (eds.): Optical Coherence Tomography - Springer 2008
- L. Wang (ed): Photoacoustic Imaging and Spectroscoy - CRC Press 2009

Language:

- offered only in German

ME4423 T - Module part: Laserphysics and -technologies (LaPhyTec)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Master MES 2020 (module part), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), biophysics, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), medical engineering science, 1st semester

Classes and lectures:

- Lecture laser physics and -technologies (lecture, 2 SWS)

Workload:

- 45 Hours private studies and exercises
- 30 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Understanding the laser (What is a laser, the laser history, laser parameters)
- Basic properties of light, light propagation (Gaussian beam resonators, stability conditions, wavelength selective elements)
- Light and matter (radiation interactions, stimulated and spontaneous emission light amplification)
- Laser (Broad laser theory, rate equations, laser threshold, laser dynamics)
- Types of lasers (gas lasers, ion lasers, solid state lasers, fiber lasers, semiconductor lasers)
- nonlinear optics (frequency doubling and conversion)
- Ultrashort light pulses

Qualification-goals/Competencies:

- Students can assess what types of lasers are suitable for which applications.
- They can implement concepts for new laser applications.
- They can list the most important types of lasers.
- They can explain the basic concepts of laser physics.
- They can analyze laser formally.
- They can assess the potential of laser radiation on the basis of the parameters.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Robert Huber
- Dr. rer. nat. Ralf Brinkmann
- Prof. Dr. rer. nat. Sebastian Karpf

Literature:

- Dieter Meschede: Optics, Light and Lasers - Wiley-VCH 2007
- Walter Koechner: Solid State Laser Engineering - Springer 1999
- Saleh/Teich: Grundlagen der Photonik - Wiley-VCH 2008

Language:

- offered only in German

PS5000-KP06, PS5000 - Student Conference (ST)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6 (Typ B)

Course of study, specific field and term:

- Master MES 2020 (compulsory), interdisciplinary competence, 3rd semester
- Master Medical Informatics 2019 (compulsory), interdisciplinary competence, 3rd semester
- Master Biophysics 2019 (compulsory), biophysics, 3rd semester
- Master Auditory Technology 2017 (compulsory), Auditory Technology, 3rd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, arbitrary semester
- Master Robotics and Autonomous Systems 2019 (compulsory), Robotics and Autonomous Systems, 3rd semester
- Master Medical Informatics 2014 (compulsory), interdisciplinary competence, 3rd semester
- Master MES 2014 (compulsory), interdisciplinary competence, 3rd semester

Classes and lectures:

- Student Conference (seminar, 4 SWS)

Workload:

- 155 Hours work on an individual topic (research and development) and written elaboration
- 25 Hours in-classroom work

Contents of teaching:

- Preparation of a scientific publication in English based on the results of at least one of the project internships
- Preparation of a scientific poster in English based on the results of at least one of the project internships
- Presentation of a scientific poster in German or English, based on the results of at least one of the project internships
- Talk in English based on the results of at least one of the project internships
- Active participation in scientific discussions
- Active participation in a scientific peer-review process

Qualification-goals/Competencies:

- Students have experience in a comprehensive review of a scientific topic
- They are able to get an extensive overview of a complex scientific area
- They have the experience and ability to take an active part in scientific discussions
- They are able to defend one's work successfully in a scientific discourse
- They have knowledge of the peer-review process of publications
- They are able to constructively criticize in a blind peer-review process
-

Grading through:

- B-Certificate (not graded)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels
- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- All Institutes and Clinics of the Universität zu Lübeck

Literature:

- is selected individually:

Language:

- offered only in English

Notes:

Because the content of the presentation should reflect the results of at least one of the project internships, the students will be supervised by the same university lecturer that supervised the internships. Internships can be carried out at home or abroad in medical technology companies, audiology companies and IT companies in the healthcare industry as well as hospitals and scientific institutions. The supervision by an university lecturer is obligatory.

CS4220 T - Module part: Pattern Recognition (MEa)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master Auditory Technology 2017 (module part), Auditory Technology, 2nd semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master Computer Science 2014 (module part), advanced curriculum, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st semester
- Master Computer Science 2014 (module part), specialization field robotics and automation, arbitrary semester

Classes and lectures:

- Pattern Recognition (lecture, 2 SWS)
- Pattern Recognition (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction to probability theory
- Principles of feature extraction and pattern recognition
- Bayes decision theory
- Discriminance functions
- Neyman-Pearson test
- Receiver Operating Characteristic
- Parametric and nonparametric density estimation
- kNN classifiers
- Linear classifiers
- Support vector machines and kernel trick
- Random Forest
- Neural Nets
- Feature reduction and feature transforms
- Validation of classifiers
- Selected application scenarios: acoustic scene classification for the selection of hearing-aid algorithms, acoustic event recognition, attention classification based on EEG data, speaker and emotion recognition

Qualification-goals/Competencies:

- Students are able to describe the main elements of feature extraction and pattern recognition.
- They are able to explain the basic elements of statistical modeling.
- They are able to use feature extraction, feature reduction and pattern classification techniques in practice.

Grading through:

- exam type depends on main module

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Alfred Mertins

Literature:

- R. O. Duda, P. E. Hart, D. G. Storck: Pattern Classification - New York: Wiley

Language:

- offered only in German

CS4405 T - Module part: NeuroInformatics (NeuroInfa)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Medical Informatics 2019 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master Medical Informatics 2014 (module part), module part, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 2nd semester
- Master Computer Science 2014 (module part), module part, arbitrary semester

Classes and lectures:

- NeuroInformatics (lecture, 2 SWS)
- NeuroInformatics (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- The human brain and abstract neuron models
- Learning with a single neuron:* Perceptrons* Max-Margin Classification* LDA and logistic Regression
- Network architectures:* Hopfield-Networks* Multilayer-Perceptrons* Deep Learning
- Unxupervised Learning:* k-means, Neural Gas and SOMs* PCA & ICA* Sparse Coding

Qualification-goals/Competencies:

- The students are able to understand the principle function of a single neuron and the brain as a whole.
- They know abstract neuronal models and they are able to name practical applications for the different variants.
- They are able to derive a learning rule from a given error function.
- They are able to apply (and implement) the proposed learning rules and approaches to solve unknown practical problems.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr. rer. nat. Thomas Martinetz

Literature:

- S. Haykin: Neural Networks - London: Prentice Hall, 1999
- J. Hertz, A. Krogh, R. Palmer: Introduction to the Theory of Neural Computation - Addison Wesley, 1991
- T. Kohonen: Self-Organizing Maps - Berlin: Springer, 1995
- H. Ritter, T. Martinetz, K. Schulten: Neuronale Netze: Eine Einführung in die Neuroinformatik selbstorganisierender Netzwerke - Bonn: Addison Wesley, 1991

Language:

- offered only in German

CS4442-KP12 - Systembiologie und Bioinformatik (SysBioInf)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every winter semester	12

Course of study, specific field and term:

- Master Biophysics 2019 (advanced curriculum), advanced curriculum, 1st and 2nd semester

Classes and lectures:

- Molecular Bioinformatics (lecture, 2 SWS)
- Molecular Bioinformatics (exercise, 1 SWS)
- Modelling of Biological Systems (lecture, 2 SWS)
- Modelling of Biological Systems (exercise, 1 SWS)
- Introduction to classic and translational system biology (lecture, 2 SWS)
- Introduction to classic and translational system biology (exercise, 2 SWS)

Workload:

- 170 Hours private studies
- 150 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Methods for fast genome comparison
- Analysis of data describing gene expression profiles and sequence variation
- Advanced usage of biological databases (for sequences, motifs, structures, gene regulation and interactions)
- Elementary time-discrete deterministic models
- Structured time-discrete population dynamics
- Generating functions, Galton-Watson-processes
- Markov chains with applications
- Modeling of data and data analysis
- Introduction to the genome and proteome of cellular systems
- Networks: cellular, genetic, gene-regulatory networks, interactomes
- Analysis of dynamical systems: fixed points, bifurcations and feedback
- Bioinformatic analysis of Omics data
- Introduction to public databases: e.g. STRING, Gene Expression Omnibus, TCGA, KEGG, Reactome, MSigDB
- Exercises: computer lab for analysis of dynamical systems and cellular pathways in R
- Usage, analysis and visualization of high-dimensional data in R
- Exercises for the analysis of protein interaction networks

Qualification-goals/Competencies:

- The students can apply indexing based software to Next Generation sequence data.
- They can use and design databases for molecularbiological research.
- They are able to detect statistically significant changes in Microarray data.
- Students have knowledge of elementary time-discrete models for modeling biological processes
- They develop skills in connecting ideas from different fields of mathematics
- They have competencies in data analysis and modelling
- They develop competencies in interdisciplinary work
- The students can explain the principles of signal transduction in the cell
- The students can relate to the genome, transcriptome, interactome and proteome
- They can analyse and characterize dynamical systems
- They know common methods to analyse high-throughput data
- Lab work will enable the students to continue studying this subject on their own

Grading through:

- Oral examination

Requires:

- Stochastics 1 (MA2510-KP04, MA2510)
- Analysis 2 (MA2500-KP04, MA2500)
- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Introduction to Bioinformatics (CS1400-KP04, CS1400)

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- LIED | Lübecker Institut für experimentelle Dermatologie (Lübeck Institute of Experimental Dermatology)
- Institute for Mathematics
- Institute for Neuro- and Bioinformatics

- Prof. Dr. Bernhard Haubold
- Prof. Dr. rer. nat. Thomas Martinetz
- Dr. rer. nat. Kurt Fellenberg
- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. Hauke Busch
- Dr. Axel Künstner

Literature:

- M. S. Waterman: Introduction to Computational Biology - London: Chapman and Hall 1995
- B. Haubold, T. Wiehe: Introduction to Computational Biology - Birkhäuser 2007
- R. Durbin, S. Eddy, A. Krogh, G. Mitchison: Biological sequence analysis. Probabilistic models - Cambridge, MA: Cambridge University Press
- J. Setubal, J. Meidanis: Introduction to computational molecular - Pacific Grove: PWS Publishing Company
- D. M. Mount: Bioinformatics - Sequence and Genome - New York: Cold Spring Harbor Press
- F. Braer, C. Castillo-Chavez: Mathematical Models in Population Biology and Epidemiology - New York: Springer 2000
- H. Caswell: Matrix Population Modells - Sunderland: Sinauer Associates 2001
- S. N. Elaydi: An Introduction to Difference Equations - New York: Springer 1999
- B. Huppert: Angewandte Lineare Algebra - Berlin: de Gruyter 1990
- U. Krengel: Einführung in die Wahrscheinlichkeitstheorie und Statistik - Wiesbaden: Vieweg 2002
- E. Seneta: Non-negative Matrices and Markov Chains - New York: Springer 1981
- Marian Walhout, Marc Vidal, Job Dekker: Handbook of Systems Biology: Concepts and Insights - (Englisch) Gebundene Ausgabe 15. November 2012
- Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald;: Systems Biology: A Textbook - Englisch) Taschenbuch 20. April 2016
- Yoram Vodovotz and Gary: An Translational Systems Biology, Concepts and Practice for the Future of Biomedical Research

Language:

- German and English skills required

CS4510-KP12, CS4510 - Signal Analysis (SignalAna)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master MES 2020 (advanced module), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), technology field computer science, arbitrary semester
- Master Computer Science 2019 (optional subject), advence module, arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master MES 2014 (advanced module), computer science / electrical engineering, 1st and/or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), technology field computer science, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- - CS4220 T: Pattern Recognition (lecture with exercises, 3 SWS)
- - CS5275 T: Selected Topics of Signal Analysis and Enhancement (lecture with exercises, 3 SWS)
- CS5194 T: Lab course (project work, 3 SWS)

Workload:

- 150 Hours private studies
- 90 Hours in-classroom work
- 60 Hours group work
- 40 Hours exam preparation
- 20 Hours written report

Contents of teaching:

- Introduction to statistical signal analysis
- Principles of feature extraction and pattern recognition
- Linear optimum filters
- Adaptive filters
- Spectrum analysis
- Basic concepts of multirate signal processing
- Applications in speech and image processing
- Realization of signal processing tasks for typical application scenarios in teamwork

Qualification-goals/Competencies:

- Students are able to explain the basic elements of stochastic signal processing and optimum filtering.
- They are able to describe and apply linear estimation theory.
- Students are able to describe the concepts of adaptive signal processing.
- They are able to explain theconcepts of feature extraction and pattern recognition.
- They are able to analyze and design multirate systems.
- Students are able to explain various practical applications of signal processing algorithms.
- They are able to create and implement signal processing systems on their own and in teamwork.

Grading through:

- successful addressing of the project goals

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins

Literature:

- : See description of module parts

Language:

- German and English skills required

CS4511-KP12, CS4511 - Learning Systems (LernSys)

Duration:	Turnus of offer:	Credit points:
2 Semester	irregularly	12

Course of study, specific field and term:

- Master Computer Science 2019 (optional subject), Canonical Specialization Bioinformatics and Systems Biology, arbitrary semester
- Master MES 2020 (advanced module), computer science / electrical engineering, arbitrary semester
- Master Computer Science 2019 (optional subject), Canonical Specialization Data Science and AI, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), technology field computer science, arbitrary semester
- Master Computer Science 2019 (optional subject), advence module, arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master MES 2014 (advanced module), computer science / electrical engineering, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), technology field computer science, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- CS4405 T: Neuro Informatics (lecture with exercises, 3 SWS)
- CS5450 T: Machine Learning (lecture with exercises, 3 SWS)
- CS5430 T: Seminar Machine Learning (seminar, 2 SWS)

Workload:

- 180 Hours private studies
- 120 Hours in-classroom work
- 40 Hours exam preparation
- 20 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- Prof. Dr.-Ing. Erhardt Barth

Literature:

- : see module parts

Language:

- German and English skills required

CS5194 T - Module part: Practical Project in Signal and Image Processing (PrBildSiga)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	every second semester	4 (Typ B)

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st or 2nd semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master Computer Science 2014 (module part), module part, arbitrary semester

Classes and lectures:

- iRoom (practical course, 3 SWS)

Workload:

- 60 Hours group work
- 40 Hours private studies
- 20 Hours written report

Contents of teaching:

- Planning and realization of typical signal processing applications in a team

Qualification-goals/Competencies:

- Students will have comprehensive knowledge of using signal and image processing algorithms in practice.
- They are able to realize signal processing systems in teamwork and in a self-directed manner.
- They have the communication competency to document and present project results.

Grading through:

- exam type depends on main module

Requires:

- Signal processing (CS3100-KP04)
- Image processing (CS3203)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Signal Processing

- Prof. Dr.-Ing. Alfred Mertins
- MitarbeiterInnen des Instituts

Language:

- offered only in German

CS5275 T - Module part: Selected Topics of Signal Analysis and Enhancement (AMSAVa)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master Auditory Technology 2017 (module part), Auditory Technology, 2nd semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (module part), module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Computer Science 2014 (module part), module part, arbitrary semester

Classes and lectures:

- Selected Topics of Signal Analysis and Enhancement (lecture, 2 SWS)
- Selected Topics of Signal Analysis and Enhancement (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction to statistical signal analysis
- Autocorrelation and spectral estimation
- Linear estimators
- Linear optimal filters
- Adaptive filters
- Multichannel signal processing, beamforming, and source separation
- Compressed sensing
- Basic concepts of multirate signal processing
- Nonlinear signal processing algorithms
- Application scenarios in auditory technology, enhancement, and restauration of one- and higher-dimensional signals, Sound-field measurement, noise reduction, deconvolution (listening-room compensation), inpainting

Qualification-goals/Competencies:

- Students are able to explain the basic elements of stochastic signal processing and optimum filtering.
- They are able to describe and apply linear estimation theory.
- Students are able to describe the concepts of adaptive signal processing.
- They are able to describe and apply the concepts of multichannel signal processing.
- They are able to describe the concept of compressed sensing.
- They are able to analyze and design multirate systems.
- Students are able to explain various applications of nonlinear and adaptive signal processing.
- They are able to create and implement linear optimum filters and nonlinear signal enhancement techniques on their own.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und

Signalschätzung - Springer-Vieweg, 3. Auflage, 2013
- S. Haykin: Adaptive Filter Theory - Prentice Hall, 1995

Language:

- German and English skills required

Notes:

According to the PVO the only exam in this module is a written test. Prerequisites are exercises. These must have been done and graded positively before the first exam.

(Is part of module CS4290, 4510, 5400, RO4290-KP04, CS5274-KP08)
(Is the same as CS5275)

CS5430 T - module part: Seminar Machine Learning (SemMaschLa)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master Computer Science 2014 (module part), module part, arbitrary semester

Classes and lectures:

- Seminar Machine Learning (seminar, 2 SWS)

Workload:

- 70 Hours private studies
- 30 Hours in-classroom work
- 20 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- Independent study of a specific field of machine learning

Qualification-goals/Competencies:

- Learning the basics of scientific work

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr.-Ing. Erhardt Barth
- MitarbeiterInnen des Instituts

Language:

- German and English skills required

CS5450 T - Module part: Machine Learning (MaschLerna)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st semester
- Master IT-Security 2019 (module part), module part, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (module part), module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), module part, arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Computer Science 2014 (module part), module part, arbitrary semester

Classes and lectures:

- Machine Learning (lecture, 2 SWS)
- Machine Learning (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Representation learning, including manifold learning
- Statistical learning theory
- VC dimension and support vector machines
- Boosting
- Deep learning
- Limits of induction and importance of data ponderation

Qualification-goals/Competencies:

- Students can understand and explain various machine-learning problems.
- They can explain and apply different machine learning methods and algorithms.
- They can chose and then evaluate an appropriate method for a particular learning problem.
- They can understand and explain the limits of automatic data analysis.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr.-Ing. Erhardt Barth
- Prof. Dr. rer. nat. Thomas Martinetz

Literature:

- Chris Bishop: Pattern Recognition and Machine Learning - Springer ISBN 0-387-31073-8
- Vladimir Vapnik: Statistical Learning Theory - Wiley-Interscience, ISBN 0471030031
- Tom Mitchell: Machine Learning - McGraw Hill. ISBN 0-07-042807-7

Language:

- English, except in case of only German-speaking participants

LS4031-KP12 - Zell- und molekularbiologische Pathomechanismen und Therapieansätze (ZMolPath)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every winter semester	12

Course of study, specific field and term:

- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester

Classes and lectures:

- Pharmakologie und Toxikologie (lecture, 2 SWS)
- Drug Design (lecture, 2 SWS)
- Cell Biology (lecture, 2 SWS)
- General virology and biosafety (lecture, 2 SWS)

Workload:

- 240 Hours private studies
- 120 Hours in-classroom work

Contents of teaching:

- Introduction into Pharmacology
- Pharmacodynamic
- Pharmacokinetics
- Oral Antidiabetics
- Pharmacology of the Renin-Angiotensin-Aldosterone-System
- Cerebrovascular Pharmacology
- Reverse Pharmacology
- Pharmacology of Thyroid Homones
- Sleep and Hypnotics
- Antiepileptic Drugs
- Gene Therapy
- Pain physiology and analgetic therapies
- Concepts in Drug Design
- NMR experiments for Drug Design
- Case Study: Omeprazole vs. Tamiflu
- Chemical Synthesis of Drugs - Combinatorial Approaches
- Drug Discovery - An Overview
- Target Identification and Validation
- X-ray Crystallography in Drug Design
- Structure-based drug design - Principles and Methods
- Secretion in pro- and eukaryotes
- Structure, function biogenesis and stasis of membraneouse compartments of eukaryotes
- Cellular fusion, cytokinesis and organellar inheritence
- RNA-metabolism
- History of virology
- Virus taxonomy and structure
- Virus morphology in overview
- Viral life cycles (entry, assembly, budding)
- Replication mechanisms
- Viral evolution
- Basic techniques in virology and methods of virus diagnostics
- Blood-borne viruses and safety of blood products
- Biosafety classification of viruses according to Gentechnikrecht and Biostoffverordnung

Qualification-goals/Competencies:

- Effects of therapeutic drugs on the organism (Pharmacodynamics)
- Time course of therapeutic drug concentrations in the organism (Pharmacokinetics)
- Mechanisms of action of various substance classes
- Experimental methods in pharmacology
- Basic strategies of Drug Design
- The way from the target discovery to the drug. Techniques of rational Drug Design
- The relationship between chemical structure and effect and the techniques for theoretical prognosis and experimental tests, particular x-ray crystallography and NMR-experiments
- The students should know the borders of x-ray crystallography and NMR-experiments

- Ability to link the newly communicated detailed cell biology knowledge with the already acquired knowledge and to apply it in the context of other modules
- Ability, to recognize the connection between the cell biology of hosts and the molecular strategies of viral and other microbiological parasites
- They can categorize viruses systematically
- They can explain and compare viral life cycles and replication strategies
- They can list basic practices and protocols for the virological safety of blood products
- They can apply basics knowledge according to Gentechnikrecht and Biostoffverordnung

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Enno Hartmann
- Prof. Dr. rer. nat. Thomas Peters

Teacher:

- Institute of Virology and Cell Biology
- Institute for Biology
- Institute of Chemistry and Metabolomics
- Institute of Experimental and Clinical Pharmacology and Toxicology
- Institute of Molecular Medicine
- Institute of Biochemistry

- Prof. Dr. rer. nat. Thomas Peters
- Prof. Dr. rer. nat. Olaf Jöhren
- PD Dr. Martin Tegtmeier
- Dr. rer. nat. Jan Wenzel
- Prof. Dr. rer. nat. Tobias Restle
- Dr. rer. nat. Alessandra Mescalchin
- Prof. Dr. rer. nat. Rolf Hilgenfeld
- Prof. Dr. med. Markus Schwaninger
- Dr. med. Dirk Ridder
- Prof. Dr. rer. nat. Walter Raasch
- Prof. Dr. rer. nat. Norbert Tautz
- Dr. rer. nat. Olaf Isken
- Prof. Dr. rer. nat. Enno Hartmann
- Prof. Dr. rer. medic. Lisa Marshall
- Dr. rer. nat. Dipl.-Psych. Sonja Binder
- Dr. rer. nat. Sivaraj Mohana Sundaram
- Dr. rer. nat. Marietta Zille
- Dr.rer.nat Sonja Petkovic
- Dr. Lars Redecke
- Dr. math. et dis. nat. Jeroen Mesters

Literature:

- Goodman & Gilman's: The Pharmacologic Basis of Therapeutics - von Brunton L, Lazo J, Parker K, - 12th Ed., McGraw-Hill 2011, ISBN 0071422803
- Lüllmann H. Mohr K. Hein L.: Pocket Atlas of Pharmacology - 4th Ed., Thieme 2011, ISBN 9783131503114
- G. Klebe: Wirkstoffdesign - Spektrum-Verlag Heidelberg, 2009. ISBN 978-3-8274-2046-6
- A. Hillisch & R. Hilgenfeld, Birkhäuser: Modern Methods in Drug Discovery - Basel, Boston, Berlin 2003, ISBN 3-7643-6081-X
- : Grundlagen- und Übersichtsartikel für beide Veranstaltungen
- Lodish: Molecular Cell Biology
- Alberts: Molecular Biology of the Cell
- S.J. Flint et al.: Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses - American Society Microbiology, February 2009, 3rd Ed., ISBN: 978-1-55581-443-4

Language:

- offered only in English

MA4030 T - Module part: Optimization (OptiT)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master MES 2014 (module part), mathematics / natural sciences, 2nd semester

Classes and lectures:

- Optimization (lecture, 4 SWS)
- Optimization (exercise, 2 SWS)

Workload:

- 130 Hours private studies and exercises
- 90 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Linear optimization (Simplex method)
- Unconstrained nonlinear optimization (gradient descent, Newton method, Quasi-Newton methods)
- Constrained nonlinear optimization (Lagrange multipliers)
- Discrete optimization

Qualification-goals/Competencies:

- Students can model real-life problems as optimization problems.
- They understand central optimization techniques.
- They can explain central optimization techniques.
- They can compare and assess central optimization techniques.
- They can implement central optimization techniques.
- They can assess numerical results.
- They can select suitable optimization techniques for practical problems.
- Interdisciplinary qualifications:
- Students can transfer theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- exam type depends on main module

Is requisite for:

- Multi- and High-Dimensional Data Processing (MA5036-KP05)
- Non-smooth Optimization and Analysis (MA5035-KP05)

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- J. Nocedal, S. Wright: Numerical Optimization - Springer
- F. Jarre: Optimierung - Springer
- C. Geiger: Theorie und Numerik restringierter Optimierungsaufgaben - Springer

Language:

- offered only in German

Notes:

(Sub-module of MA4310)

Prerequisite tasks for taking the exam can be announced at the beginning of the semester.
If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MA4300-KP12, MA4300 - Modellierung und Analyse zeitabhängiger biologischer Prozesse und Daten (MAPD)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every winter semester	12

Course of study, specific field and term:

- Master MES 2020 (advanced module), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester
- Master MES 2014 (advanced module), mathematics / natural sciences, 1st and 2nd semester

Classes and lectures:

- MA4330 T: Module part: Biosignalanalyse (4ECTS) (course, 3 SWS)
- MA4450 T: Module part: Modellierung Biologischer Systeme (8 ECTS) (course, 4 SWS)

Workload:

- 225 Hours private studies and exercises
- 105 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- see description of module parts

Qualification-goals/Competencies:

- see description of module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- see literature of module parts:

Language:

- offered only in German

MA4310-KP12, MA4310 - Numerical Optimization (NumOpt)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	12

Course of study, specific field and term:

- Master MES 2020 (advanced module), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 2nd semester
- Master MES 2014 (advanced module), mathematics / natural sciences, 2nd semester

Classes and lectures:

- MA4030 T: Module part: Optimization (lecture, 4 SWS)
- MA5034 T: Module part: Calculus of Variations and Partial Differential Equations (4ECTS) (course, 3 SWS)
- MA5032 T: Module part: Numerical Methods for Image Computing (4ECTS) (course, 3 SWS)
- MA4030 T: Module part: Optimization (exercise, 2 SWS)

Workload:

- 195 Hours private studies and exercises
- 135 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- as stated in module parts

Qualification-goals/Competencies:

- as stated in module parts

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- as stated in module parts:

Language:

- German and English skills required

Notes:

The module MA4310: Numerical Optimization consists of the module MA4030: Optimization and annually alternating of the module MA5034: Calculus of Variations and Partial Differential Equations or the module MA5032: Numerical Methods for Image Computing.

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MA4330 T - Module part: Biosignal analysis (BioSAT)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master MES 2014 (module part), mathematics / natural sciences, 2nd semester

Classes and lectures:

- Biosignal analysis (lecture, 2 SWS)
- Biosignal analysis (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Hilbert spaces
- Fourier series and Fourier transformation
- generalized functions
- discrete wavelet tranformation
- least square techniques
- application to biological and medical data

Qualification-goals/Competencies:

- Students have deepened knowledges of the mathematical background of signal analysis
- They master different methods of one-dimensional signal analysis
- They have practical skills in the application of these methods
- They have skills in working with Mathematica or MatLab

Grading through:

- exam type depends on main module

Requires:

- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- S. Mallat: A wavelet tour of signal processing - Academic Press, 1998
- A. N. Kolmogorov, S.V. Fomin: Reelle Funktionen und Funktionalanalysis - Deutscher Verlag der Wissenschaften 1975

Language:

- offered only in German

MA4450 T - Module part: Modeling Biological Systems (MoBST)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st semester
- Master MES 2014 (module part), mathematics / natural sciences, 1st semester

Classes and lectures:

- Modeling Biological Systems (lecture, 2 SWS)
- Modeling Biological Systems (exercise, 2 SWS)

Workload:

- 160 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Elementary time-discrete deterministic models
- Structured time-discrete population dynamics
- Generating functions, Galton-Watson processes
- Markov chains with applications
- Modeling of data and data analysis

Qualification-goals/Competencies:

- Students have knowledge of elementary time-discrete models for modeling biological processes
- They develop skills in connecting ideas from different fields of mathematics
- They have competencies in data analysis and modelling
- They develop competencies in interdisciplinary work

Grading through:

- exam type depends on main module
- Exercises

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Stochastics 1 (MA2510-KP04, MA2510)
- Analysis 2 (MA2500-MML)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller

Literature:

- F. Braer, C. Castillo-Chavez: Mathematical Models in Population Biology - New York: Springer 2000
- H. Caswell: Matrix Population Models - Sunderland: Sinauer Associates 2001
- S. N. Elaydi: An Introduction to Difference Equations - New York: Springer 1999
- B. Huppert: Angewandte Lineare Algebra - Berlin: de Gruyter 1990
- U. Krengel: Einführung in die Wahrscheinlichkeitstheorie und Statistik - Wiesbaden: Vieweg 2002
- E. Seneta: Non-negative Matrices and Markov Chains - New York: Springer 1981

Language:

- offered only in German

Notes:

The lecture is identical to that in module
MA4450.

MA5032 T - Module part: Numerical Methods for Image Computing (NumerikBVT)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second summer semester	4

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master MES 2014 (module part), mathematics / natural sciences, 2nd semester

Classes and lectures:

- Numerical Methods for Image Computing (lecture, 2 SWS)
- Numerical Methods for Image Computing (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Modeling
- Discretization
- Numerical methods for partial differential equations
- Multilevel and multiscale approaches
- Optimization methods
- Multigrid methods
- Operator splitting

Qualification-goals/Competencies:

- The students are familiar with fundamental numerical concepts in image computing.
- They have experience in realizing practical solutions.
- They can implement numerical algorithms on a computer.
- They understand selected methods for solving large linear systems.
- They can implement selected methods for solving large linear systems.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- Nocedal Wright: Numerical Optimization - Springer, 2006
- Modersitzki: FAIR: Flexible Algorithms for Image Registration - SIAM, 2009
- Weickert: Anisotropic Diffusion in Image Processing - Wiley, 1998

Language:

- German and English skills required

Notes:

(Sub-module of MA4310)

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MA5034 T - Module part: Calculus of Variations and Partial Differential Equations (VariPDET)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second summer semester	4

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master MES 2014 (module part), mathematics / natural sciences, 2nd semester

Classes and lectures:

- Calculus of Variations and Partial Differential Equations (lecture, 2 SWS)
- Calculus of Variations and Partial Differential Equations (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Fundamentals of functional analysis
- Introduction to the calculus of variations
- Introduction to partial differential equations
- Applications in image and data processing

Qualification-goals/Competencies:

- Students understand variational modeling.
- They are able to formulate basic physical problems in a variational setting.
- They understand the connections between variational methods and partial differential equations.
- They can derive optimality conditions for energy functionals.
- They understand the mathematical theory behind selected variational problems.
- They can implement selected fundamental variational problems.
- They can formulate selected practical problems in the variational setting.
- Interdisciplinary qualifications:
- Students have advanced skills in modeling.
- They can translate theoretical concepts into practical solutions.
- They are experienced in implementation.
- They can think abstractly about practical problems.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Mathematics and Image Computing

- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- Chan & Shen: Image Processing and Analysis - SIAM
- Modersitzki: Flexible Algorithms for Image Registration - SIAM
- Vogel: Computational Methods for Inverse Methods - SIAM
- Aubert, Kornprobst: Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations - Springer
- Scherzer, Grasmair, Grossauer, Haltmeier, Lenzen: Variational Methods in Imaging - Springer

Language:

- German and English skills required

Notes:

(Sub-module of MA4310)

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

MZ4110-KP12 - Neurowissenschaften (Neuro)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every winter semester	12

Course of study, specific field and term:

- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester

Classes and lectures:

- Neurowissenschaften 1 (lecture, 2 SWS)
- Neurowissenschaften 1 (seminar, 2 SWS)
- Neurowissenschaften 2 (lecture, 2 SWS)
- Neurowissenschaften 2 (seminar, 2 SWS)

Workload:

- 240 Hours private studies
- 120 Hours in-classroom work

Contents of teaching:

- Electrical activity of neurons
- Electrical activity of neurons
- Channels and transporters in neurons
- Synaptic transmission
- Neurotransmitters and their receptors
- Intracellular signaling in neurons
- Plasticity and memory
- Circadian rhythms and sleep
- The visual system
- Development of the nervous system
- Stem and progenitor cells
- Alzheimer's disease
- Pathophysiology of cerebrovascular disorders
- Neuroimmunology of Multiple Sclerosis
- Epilepsy
- Pahtogens of the brain
- Parkinson's disease and other movement disorders
- Neurogenetic diseases
- Schizophrenie
- Neuropathies
- Neurometabolic diseases

Qualification-goals/Competencies:

- Understanding basics of neuroscience
- Understanding the structure and development of the brain
- Understanding neuronal excitation and signal transmission
- Introduction to examples of behavior and plasticity
- Introduction to neuronal stem cells
- Introduction to various neuropathological diseases
- Understanding molecular mechanisms of neuropathological diseases

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Olaf Jöhren

Teacher:

- Department of Neurology
- Medical Clinic I
- Department of Neurosurgery
- Institut of Physiology
- Institute of Experimental and Clinical Pharmacology and Toxicology

- Prof. Dr. rer. nat. Olaf Jöhren
- Prof. Dr. med. Cor de Wit
- Prof. Dr. rer. nat. Henrik Oster
- Prof. Dr. med. Markus Schwaninger
- PD Dr. rer. nat. Christina Zechel
- Prof. Dr. rer. nat. Katja Lohmann
- PD Dr. Sc. Ana Westenberger

Literature:

- Nicholls: From Neuron to Brain: A Cellular and Molecular Approach to the Function of the Nervous System - ISBN-10: 0878936092, 679 Seiten, Palgrave Macmillan; 5th edition (2012
- Purves: Neuroscience - ISBN-10: 0878936955, 858 Seiten, Palgrave Macmillan; 5th edition. (2011)
- Brady: Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology - ISBN-10: 0123749476, 1096 Seiten, Academic Press; 8th Edition (2011)
- : Original publications and Reviews
- Purves: Neuroscience - ISBN-10: 0878936955, Palgrave Macmillan; 5th edition. (2011)

Language:

- offered only in German

CS4440 T - Module part: Molecular Bioinformatics (MolBioInfa)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Computer Science 2019 (module part), module part, arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), module part, arbitrary semester
- Master Medical Informatics 2019 (module part), module part, arbitrary semester
- Master MLS 2009 (module part), interdisciplinary competence, 1st semester
- Master Medical Informatics 2014 (module part), module part, arbitrary semester
- Master Computer Science 2014 (module part), module part, arbitrary semester
- Master Biophysics 2019 (), module part, arbitrary semester

Classes and lectures:

- Molecular Bioinformatics (lecture, 2 SWS)
- Molecular Bioinformatics (exercise, 1 SWS)

Workload:

- 45 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Methods for fast genome comparison
- Analysis of data describing gene expression profiles and sequence variation
- Advanced usage of biological databases (for sequences, motifs, structures, gene regulation and interactions)

Qualification-goals/Competencies:

- The students can apply indexing based software to Next Generation sequence data.
- They can use and design databases for molecularbiological research.
- They are able to detect statistically significant changes in Microarray data.

Grading through:

- exam type depends on main module

Requires:

- Introduction to Bioinformatics (CS1400-KP04, CS1400)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. Bernhard Haubold
- Prof. Dr. rer. nat. Thomas Martinetz
- Dr. rer. nat. Kurt Fellenberg
- MitarbeiterInnen des Instituts

Literature:

- M. S. Waterman: Introduction to Computational Biology - London: Chapman and Hall 1995
- B. Haubold, T. Wiehe: Introduction to Computational Biology - Birkhäuser 2007
- R. Durbin, S. Eddy, A. Krogh, G. Mitchison: Biological sequence analysis. Probabilistic models - Cambridge, MA: Cambridge University Press
- J. Setubal, J. Meidanis: Introduction to computational molecular - Pacific Grove: PWS Publishing Company
- D. M. Mount: Bioinformatics - Sequence and Genome - New York: Cold Spring Harbor Press

Language:

- offered only in German

Notes:

This modul is for Master MLS the Modulpart B of Modul LS4060 with 5 credit points.

CS3010-KP04, CS3010 - Human-Computer-Interaction (MCI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, arbitrary semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Master Biophysics 2019 (optional subject), Elective, 1st semester
- Master Psychology 2016 (optional subject), interdisciplinary competence
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 5th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, arbitrary semester
- Master psychology 2013 (optional subject), interdisciplinary competence, 3rd semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 5th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester

Classes and lectures:

- Human-Computer-Interaction (lecture, 2 SWS)
- Human-Computer-Interaction (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction and overview of the topic area
- Norms and legal foundations
- Human information processing and processes of actions
- Models for human-computer systems and interactive media
- Input/Output devices and interaction technologies
- User-centered development process and special groups of users
- Usability Engineering
- System paradigms and corresponding system examples
- Evaluation and impact analyzes
- Innovative concepts and systems

Qualification-goals/Competencies:

- The students know the principles and methods of the context-, task- and user-centered development of interactive systems.
- They have basic knowledge about human information processing and can introduce it into the design process.
- They know the basic models of interactive systems und can apply them for their analysis and evaluation.
- They have the ability to analyze and review interative systems based on criteria.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr.-Ing. Nicole Jochems

Teacher:

- Institute for Multimedia and Interactive Systems

- Prof. Dr.-Ing. Nicole Jochems

Literature:

- M. Dahm: Grundlagen der Mensch-Computer-Interaktion - Pearson Studium, 2006
- J.A. Jacko: The Human-Computer Interaction Handbook - CRC Press, 2012

Language:

- offered only in German

CS4250-KP04, CS4250 - Computer Vision (CompVision)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master MES 2020 (optional subject), computer science / electrical engineering, arbitrary semester
- Master Computer Science 2019 (optional subject), Elective, arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, arbitrary semester
- Master Biophysics 2019 (optional subject), Elective, 2nd semester
- Master Biomedical Engineering (optional subject), advanced curriculum, 2nd semester
- Master CLS 2016 (optional subject), computer science, 2nd or 3rd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, arbitrary semester
- Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master CLS 2010 (compulsory), computational life science / imaging, 2nd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd semester

Classes and lectures:

- Computer Vision (lecture, 2 SWS)
- Computer Vision (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction to human and computer vision
- Sensors, cameras, optics and projections
- Image features: edges, intrinsic dimension, Hough transform, Fourier descriptors, snakes
- Range imaging and 3-D cameras
- Motion and optical flow
- Object recognition
- Example applications

Qualification-goals/Competencies:

- Students can understand the basics of computer vision.
- They can explain and perform camera choice and calibration.
- They can explain and apply the basic methods for feature extraction, motion estimation, and object recognition.
- They can indicate appropriate methods for different kinds of computer-vision applications.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Erhardt Barth

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr.-Ing. Erhardt Barth

Literature:

- Richard Szeliski: Computer Vision: Algorithms and Applications - Springer, Boston, 2011
- David Forsyth and Jean Ponce: Computer Vision: A Modern Approach - Prentice Hall, 2003

Language:

- English, except in case of only German-speaking participants

Notes:

Prerequisites for admission to the examination can be determined at the beginning of the semester. If such prerequisites are defined, they must have been fulfilled prior to the first attempt at the examination and must have been rated as positive.

Prerequisites for admission to the examination:
Successful participation in the exercises,
minimum pass percentage: 70 %

CS4270-KP04, CS4270 - Medical Robotics (MedRob)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master MES 2020 (optional subject), computer science / electrical engineering, arbitrary semester
- Master Biophysics 2019 (optional subject), Elective, 2nd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, arbitrary semester
- Master Biomedical Engineering (optional subject), Interdisciplinary modules, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science 2012 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science 2012 (optional subject), specialization field medical informatics, 2nd or 3rd semester

Classes and lectures:

- Medical Robotics (lecture, 2 SWS)
- Medical Robotics (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

Qualification-goals/Competencies:

- The participants are able to derive the inverse kinematic equation for a given robot construction with 6 degrees of freedom, and implant it in an application.
- Design goals for a robotic application can be formulated and reduced to a practical system.
- Mathematical methods for machine learning can be applied to motion learning, considering the dynamics of motion.
- The dynamics of motion in space can be mapped to learning techniques.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Robotics and Cognitive Systems

- Prof. Dr.-Ing. Achim Schweikard

Literature:

- J. -C. Latombe: Robot Motion Planning - Dordrecht: Kluwer 1990
- J.J. Craig: Introduction to Robotics - Pearson Prentice Hall 2002
- : lecture notes (400 pages full text)

Language:

- offered only in English

CS5204-KP04, CS5204 - Artificial Intelligence 2 (KI2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master MES 2020 (optional subject), computer science / electrical engineering, arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), computer science, 1st or 2nd semester
- Master Biophysics 2019 (optional subject), Elective, 1st semester
- Master MES 2014 (optional subject), computer science / electrical engineering, arbitrary semester
- Master Biomedical Engineering (optional subject), Interdisciplinary modules, 2nd semester
- Master CLS 2016 (optional subject), computer science, 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester

Classes and lectures:

- Artificial Intelligence 2 (lecture, 2 SWS)
- Artificial Intelligence 2 (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Support Vector Machines and Dualization
- Classification
- Regression
- Time-Series Prediction
- Lagrange Multipliers
- Sequential Minimal Optimization
- Geometric Reasoning

Qualification-goals/Competencies:

- The students are able to choose a method for machine learning for a given application amongst a variety of such methods.
- The chosen method can be customized to the needs of the application. The process of customization goes well beyond straightforward search of parameters and involves adjustments to the basic mathematical techniques.This leads to innovative applications for machine learning, designed and implemented by the students.The starting point are support vector machines.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Robotics and Cognitive Systems

- Prof. Dr.-Ing. Achim Schweikard

Literature:

- P. Norvig, S. Russell: Künstliche Intelligenz - München: Pearson 2004

Language:

- offered only in English

CS5410-KP04 - Artificial Life (ArtiLife)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester
- Master CLS 2010 (optional subject), computer science, arbitrary semester
- Master CLS 2010 (optional subject), life sciences, arbitrary semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester

Classes and lectures:

- Artificial Life (lecture, 2 SWS)
- Artificial Life (exercise, 1 SWS)

Workload:

- 60 Hours private studies
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Properties, flavors and kinds of (artificial) life
- Artificial chemistry and self-replicating code
- Introduction to information theory
- Introduction to statistical mechanics and thermodynamics
- Complex networks and NK models
- Evolutionary algorithms
- Emergence
- Cellular automata
- Game of life
- Tierra
- Ant algorithms

Qualification-goals/Competencies:

- Understanding criteria and definitions of
- Understanding of
- Understanding (and ability to apply) evolutionary algorithms
- Understanding the principles of complex networks
- Knowledge of the main models of artificial life

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- PD Dr. rer. nat. Jens Christian Claussen

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- PD Dr. rer. nat. Jens Christian Claussen

Literature:

- Christoph Adami: Introduction to Artificial Life - Springer Verlag, 1998

Language:

- English, except in case of only German-speaking participants

CS5440-KP04, CS5440 - Seminar Neuro- and Bioinformatics (SemNeurBio)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester
- Master CLS 2010 (optional subject), computer science, arbitrary semester

Classes and lectures:

- Seminar Neuro- and Bioinformatics (seminar, 2 SWS)

Workload:

- 70 Hours private studies
- 30 Hours in-classroom work
- 20 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- Introduce students to a current research topic in Neuro- and Bioinformatics

Qualification-goals/Competencies:

- The students are able to read and understand scientific publications in the field of neuro- uand bioinformatics.
- They are able to present orally and in a written paper the content of scientific publications in the field of neuro- and bioinformatics.
- They can master basic scientific methodology.
- They can summarize a scientific topic in written form.
- They can give an intelligible and concise oral presentation of a current research topic.
- They have communication competency to discuss a current research topic.

Grading through:

- term paper

Responsible for this module:

- Prof. Dr.-Ing. Erhardt Barth
- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- Prof. Dr.-Ing. Erhardt Barth
- MitarbeiterInnen des Instituts

Language:

- English, except in case of only German-speaking participants

MA2600-KP04, MA2600 - Biostatistics 2 (BioStat2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester
- Master Biophysics 2019 (optional subject), Elective, 2nd semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum stochastics, 2nd semester
- Bachelor CLS 2010 (compulsory), mathematics, 4th semester

Classes and lectures:

- Biostatistics 2 (lecture, 2 SWS)
- Biostatistics 2 (exercise, 1 SWS)

Workload:

- 45 Hours in-classroom work
- 35 Hours private studies
- 25 Hours programming
- 15 Hours exam preparation

Contents of teaching:

- Knowledge of model assumptions and mathematical foundation of model assumptions for the linear model
- Knowledge of possible sources of errors in the modelling
- Competence in independent analysis of a study using the linear model
- Competence in correctly interpreting study results
- Competence in parameter interpretation and regression diagnostics
- Knowledge of model assumptions and mathematical foundation of the generalized linear model
- Competence in the independent analysis of a simple study with a dichotomous outcome
- Competence in correctly interpreting study results of a study with a dichotomous outcome

Qualification-goals/Competencies:

- Communication of knowledge of theoretical foundation of the general linear model and its application
- Communication of knowledge of theoretical foundation of the generalized linear model and its application to dichotomous endpoints

Grading through:

- written exam

Is requisite for:

- Multivariate Statistics (MA4944)
- Interdisciplinary Seminar (MA3300)

Requires:

- Biostatistics 1 (UngenutztMA1600-MML)
- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)

Responsible for this module:

- Prof. Dr. rer. biol. hum. Inke König

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. biol. hum. Inke König
- Dr. rer. hum. biol. Markus Scheinhardt

Literature:

- Ludwig Fahrmeir, Thomas Kneib, Stefan Lang: Regression: Modelle, Methoden und Anwendungen - ISBN-13 9783540339328
- Dobson, Annette J & Barnett, Adrian: An Introduction to Generalized Linear Models, 3rd ed. - Chapman & Hall/CRC: Boca Raton (FL), 2008

Language:

- offered only in German

MA4020-KP04, MA4020 - Stochastics 2 (Stoch2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st semester
- Master MES 2011 (optional subject), mathematics, 1st semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester
- Master Computer Science 2012 (compulsory), advanced curriculum stochastics, 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum analysis, 3rd semester
- Bachelor MES 2011 (optional subject), mathematics, 5th semester

Classes and lectures:

- Stochastics 2 (lecture, 2 SWS)
- Stochastics 2 (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Lebesgue integral and Riemann integral
- Transformations of measures and integrals
- Product measures and Fubini's theorem
- Moments and dependency measures
- Normally distributed random vectors and distributions closely related to the normal distribution

Qualification-goals/Competencies:

- Studends get insights into basic stochastic structures
- They master techniques of integration being relevant to stochastics
- They master the treatment of (particularly normally distributed) random vectors and their distributions
- They are able to formalize complex stochastic problems

Grading through:

- written exam

Is requisite for:

- Modeling Biological Systems (MA4450)
- Stochastic processes and modeling (MA4610-KP04, MA4610)

Requires:

- Stochastics 1 (MA2510-KP04, MA2510)
- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller

Literature:

- J. Elstrodt: Maß- und Integrationstheorie - Springer
- M. Fisz: Wahrscheinlichkeitsrechnung und mathematische Statistik - Deutscher Verlag der Wissenschaften

Language:

- offered only in German

Notes:

The lecture is identical to that in module MA4020-MML.

Only students who have passed the exercises are admitted to the examination.

MA4400-KP05 - Chaos and Complexity (ChaKomKP05)		
Duration: 1 Semester	**Turnus of offer:** irregularly	**Credit points:** 5

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester
- Bachelor CLS 2016 (optional subject), mathematics, 5th or 6th semester
- Master CLS 2016 (optional subject), mathematics, 1st, 2nd, or 3rd semester

Classes and lectures:

- Chaos and Complexity (lecture, 2 SWS)
- Chaos and Complexity (exercise, 1 SWS)

Workload:

- 85 Hours private studies and exercises
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Time-discrete dynamical systems and stochastic processes
- Nonlinearity and chaos
- Ergodicity
- Symbolic dynamics
- Information-theoretic complexity measures
- Ordinal time series analysis
- Biological and medical applications, in particular EEG analysis

Qualification-goals/Competencies:

- Students get insights into basic aspects of nonlinear dynamics
- They have skills in analyzing and modeling complex data and time series
- They have competencies in simulating and illustrating nonlinear dynamic phenomena

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Stochastics 1 (MA2510-KP04, MA2510)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Karsten Keller

Literature:

- M. Brin, G. Stuck: Introduction to Dynamical Systems - Cambridge University Press 2002
- J. M. Amigó: Permutation Complexity in Dynamical Systems - Springer 2010
- R. L. Devaney: An Introduction to Chaotic Dynamical Systems - Westview Press 2003

Language:

- depends on the chosen courses

Notes:

lecture notes in English

Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they must be completed and passed before taking the exam for the first time.

RO5202-KP04 - Module Part: Bio Robotics / Collective Robotics (CollRobo)

Duration:	Turnus of offer:	Credit points:
1 Semester	normally each year in the winter semester	4

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester

Classes and lectures:

- Collective Robotics (lecture, 2 SWS)
- Collective Robotics (exercise, 1 SWS)

Workload:

- 65 Hours private studies
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Heiko Hamann

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Heiko Hamann

Literature:

- Bonabeau, E., Dorigo, M., Theraulaz, G.: From Natural to Artificial Systems - Oxford Univ. Press, 1999
- D. Floreano, C. Mattiussi: Bio-inspired artificial intelligence: theories, methods, and technologies - The MIT Press 2008

Language:

- offered only in English

RO5600-KP06 - Social Robotics (SocRob)		
Duration:	**Turnus of offer:**	**Credit points:**
1 Semester	every second semester	6

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), Robotics and Autonomous Systems, 1st or 2nd semester

Classes and lectures:

- Social Robotics (lecture, 2 SWS)
- Social Robotics (exercise, 2 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Robotics and Cognitive Systems

- Prof. Dr.-Ing. Achim Schweikard

Language:

- offered only in English

RO5700-KP04 - Evolutionary Robotics (EvoRob)		
Duration: 1 Semester	**Turnus of offer:** irregularly	**Credit points:** 4

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester

Classes and lectures:

- Evolutionary Robotics (lecture, 2 SWS)
- Evolutionary Robotics (exercise, 1 SWS)

Workload:

- 65 Hours private studies
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Biological basics
- Evolutionary computation and optimization: encoding, search spaces, genetic operators
- Artificial neural networks
- Conducting experiments with mobile robots
- Robot simulators
- Concepts about (reactive) agents
- Nonlinear dynamic systems
- Heuristic and empirical approach in experiments
- Modular robotics
- State of the art (reality gap, Novelty Search, etc.)

Qualification-goals/Competencies:

- Students are able to explain the approach of evolutionary robotics in its entirety.
- They are able to explain evolutionary algorithms in their function as optimizers.
- They are able to implement and apply evolutionary algorithms and artificial neural networks in simulations for problems of mobile robotics.
- They are able to interpret empirical results of such simulations and to interpret possibly required changes in the approach.
- They are able to adapt parameters of the evolutionary algorithm to specific application domains.
- They are able to name challenges of evolutionary robotics in its application as well as methods to resolve them.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Heiko Hamann

Teacher:

- Institute of Computer Engineering

- Prof. Dr.-Ing. Heiko Hamann

Literature:

- Nolfi, S., Floreano, D.: The Biology, Intelligence, and Technology of Self-Organizing Machines - MIT Press, 2001
- Floreano, D., Mattiussi, C.: Bio-inspired artificial intelligence: theories, methods, and technologies - MIT Press, 2008

Language:

- offered only in English

XM1600-KP08 - Electronics and Optics (ElaOp)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st semester
- Master Biomedical Engineering (compulsory), compulsory module depending on previous knowledge , 1st semester

Classes and lectures:

- Medical Electronics [no XM1610] (lecture, 2 SWS)
- Medical Electronics [no XM1620] (project work, 4 SWS)
- Photonics I [no XM1630] (lecture, 2 SWS)

Workload:

- 120 Hours in-classroom work
- 120 Hours private studies

Contents of teaching:

- See module description of the University of Applied Sciences Lübeck.

Qualification-goals/Competencies:

- See module description of the University of Applied Sciences Lübeck.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Dipl.-Phys. Martin Ryschka

Teacher:

- Lübeck University of Applied Sciences
- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Dipl.-Phys. Martin Ryschka
- PD Dr. rer. nat. Gereon Hüttmann

Language:

- offered only in English